PRELIMINARY REPORT AND PLANS,

SHEWING THE ELEMENTS OF

HYDRAULIC DOCKS

AT MONTREAL,

WITH MANUFACTURING FACILITIES,

IN CONNECTION WITH

A CITY TERMINUS,

FOR THE

GRAND TRUNK RAILWAY.

Made under the Instructions of a Provisional Committee,

HON. JOHN YOUNG, CHAIRMAN,

BY

CHARLES LEGGE, CIVIL ENGINEER,

CORRESPONDING MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS.

MONTREAL:

PRINTED BY JOHN LOVELL, ST. NICHOLAS STREET,

1851.

PRELIMINARY REPORT AND PLANS,

SHEWING THE NECESSITY OF

HYDRAULIC DOCKS

AT MONTREAL,

WITH MANUFACTURING FACILITIES,

IN CONNECTION WITH

A CITY TERMINUS,

FOR THE

GRAND TRUNK RAILWAY.

Made under the Instructions of a Provisional Committee,
HON. JOHN YOUNG, CHAIRMAN,
BY
CHARLES LEGGE, CIVIL ENGINEER,
MONTREAL, JUNE, 1861.

Montreal:
PRINTED BY JOHN LOVELL, ST. NICHOLAS STREET,
1861.

PREFACE.

THE question of increased harbor accommodation having been long before the public, and its important bearing on the commerce of the city becoming more evident from year to year, it was resolved at an informal meeting of several of the leading merchants of Montreal, to take into consideration the most feasible method of providing additional facilities for receiving and delivering freight by the union of the oceanic with the inward or rail traffic, embracing also a suitable city terminus for the Grand Trunk Railway, the want of which has been so severely felt since the opening up of the road. As any scheme which could be devised for the accomplishment of the above purposes, would be defective if not in conjunction with increased manufacturing facilities, now also so urgently required, it was held to be of the utmost importance that in treating the subject, this necessary requirement should be kept prominently in view by adopting means for bringing into use a portion of the enormous power furnished by the River St. Lawrence in its passage down the Lachine Rapids in the immediate neighbourhood of the city; the utility of which has been so well established in the employment of the small amount of surplus water furnished by the Lachine Canal. In connection with the proposed aqueduct for supplying the water, it was also thought desirable to adopt some means for overcoming the difficulties of the Montreal Water Works Tail Race, and making use of the water furnished by the same.

With the view of obtaining plans by which the whole scheme might be definitely shewn, a provisional committee was appointed, and having nominated the Hon. John Young, chairman, empowered him to engage the services of a civil engineer, and to furnish such instructions as might enable him to carry out the various requirements in the most satisfactory manner. The perusal of the following report with the accompanying plan, will shew the nature of the instructions, in the manner in which they have been complied with.

Montreal, June 19th, 1861.

REPORT.

MONTREAL, May 2nd, 1861.

To the HON. JOHN YOUNG,
Chairman of Provisional Committee
for obtaining Plans of Hydraulic
Docks and City Terminus, G. T. R.

SIR,—Having executed the commission you honoured me with, in the preparation of Plans for the proposed Hydraulic Docks and works in connection therewith, it may perhaps be necessary in submitting them for your consideration to offer a few observations explanatory of the general features of the scheme; and, in doing so, I shall for the present confine my remarks almost exclusively to the development of the project in question, leaving for a more fitting season the preparation of an elaborated report, in which will be discussed the present and future requirements of manufactures and commerce in their bearing on the important question of greater accommodation for the rapidly increasing business of the city and Province generally.

I shall also, on that occasion, pass under review the various plans and proposals submitted by different engineers for the accomplishment of a purpose similar to the one now before us, being then, on the completion of my estimates, better prepared for instituting comparisons, and at the same time more fully ac-

quainted with the character and description of the plans and reports adverted to, as it is but this day for the first time their contents have been known to me, explaining the reason of not now being in a position to give more than the present interim report; it may however be stated that the verbal instructions received from yourself, as Chairman of the Committee, did not warrant me in preparing such information for this stage of progress, but rather to defer it until the inauguration of a Company, when more reliable and accurate estimates and details would result from an instrumental examination of the country to be occupied by the proposed improvements. Those instructions, moreover, being of a broad and general character, and not making me acquainted with the wishes and requirements of the Committee to a greater extent than that the object sought to be attained was an increased amount of harbour accommodation, with facilities for additional manufacturing establishments; a connection of rail and oceanic traffic, as well as a local city terminus for the Grand Trunk Railway; together with a tail race for the Water Works' wheel house; all of which were to be condensed into one general plan, so arranged that its constituent elements might not interfere or clash with each other, or with any public or private interests, but all work harmoniously together, or separately if requisite, was at first sight a difficult, if not impracticable engineering problem to solve; more especially as each distinct scheme had been for years past the subject of professional and commercial discussion, with great diversity of opinion entertained, not at this time necessary to be more particularly adverted to. Under such circumstances, therefore, I addressed myself to the solution of the entire question, and now beg to describe the mode in which the difficulties of the problem have been surmounted.

First, as constituting the most important feature in the scheme, reference will be made to the harbor extension in conjunction with the proposed union of inward and outward traffic, as well as the additional manufacturing facilities to be brought into being.

The great natural advantages afforded both by the river and the contiguous country for the development of this portion of the project are evident to the most cursory observer, and may be briefly sketched as follows: The portion of the river to be reclaimed is

that section lying immediately below the Victoria Bridge, and extending downwards to the foot of the Lachine Canal, commonly known as the Point St. Charles shoal, embracing altogether an area of about 300 square acres. This shoal at the present time is of no value, from the small draft of water flowing over it, and from the nature of its formation impossible to be removed by dredging or otherwise, for any sum commensurate with the useful purpose to be gained by such expenditure; but becomes invaluable in connection with the proposed improvement by surrounding it on all sides with a water-tight embankment, raised on that facing the river, to a height of 29 feet above the level of summer water in the harbor, having an entire breadth on top of 280 feet, affording space for a road 30 feet in width between the front line of the inner dock wall and the proposed reserve for building purposes, which will possess a depth of 150 feet, leaving the space of 100 feet exterior to the mills for the accommodation of four railway tracks, a cart or carriage road, and footwalk. The embankment so mentioned may be more particularly described as leaving the margin of the river near the Victoria Bridge embankment, with which it runs parallel, leaving an open space between the two of 150 feet in width for tail race purposes; and on reaching a point in the line of the outer end of the north abutment, it sweeps around to a radius of 800 feet, from thence running down the river, nearly parallel with Mill Street, to a point opposite the Lachine Canal, where turning with the same radius, it approaches the city at right angles with the line of the present harbor, and on reaching a point 1500 feet exterior to the new steamship dock, near the lower entrance of the Lachine Canal, once more sweeps around with 800 feet radius, and from thence running nearly parallel to Mill Street, with which it forms a junction opposite Grant, Hall & Company's Mill, leaving a space or open channel between itself and Mill Street, when widened as afterward to be described, of 90 feet at the upper end, and gradually increasing to 260 feet at the lower one, to serve as a tail-race for the existing mills at the foot of the present Canal, and for those to be placed on the sites furnished by the new embankment.

This tail race will be deepened (see sec. No. 4) with the material taken therefrom, going towards making up the new embank-

ment and the extension of Mill Street, thus giving greater sectional area for the water to escape, and prevent it impeding the action of the wheels by backing up. The upper, outer, and inner sides of the new basin will be devoted to flouring mills, or other establishments requiring a large amount of area and power, with immediate water, rail and cart connections; the remaining, or lower side, will be increased in width to 870 feet, forming space for a large number of smaller factories of various descriptions, with less power and accommodation requisite. These lots will be 100 feet square, laid off in a regular manner by intervening streets, with head and tail race underneath each alternately.

It may at first sight appear that, in order to build an embankment of this extent, a vast amount of material will be required; this supposition will however be dispelled, or very materially modified, on the examination of sections 1 and 4, but more especially the last, which approaches nearer the average from the fact of the first being taken in the deepest water, as well as on the side most exposed to danger from moving ice; this section shews the entire embankment to be hollow or shell-like,—in other words, the whole space occupied by the reserve for building purposes is filled up only to the level of low water, and will average generally but four feet in depth, instead of 10 feet, as shown on section 1.

In determining the height of the outer embankment, in March last, I had in view the great inundation of 1837, when the water arose to the unprecedented height of 22½ feet above summer level, but as since that period no such height had been attained, and with the ameliorating influences exercised on the river by the Victoria Bridge, and other works, to counteract or modify any such action of the water during the time to come, it might be within the limits of safety to assume a lower level for the purpose of economising the material used in forming the embankment, more especially as that leading to the Bridge averages 33 feet in height above low water, and would effectually shield and protect the one below it from the destructive action of the ice moving down the river, led me at first to entertain the idea that safety for the structures to occupy the embankment would not necessarily depend on making such provisions as would otherwise be required were there any chance of a recurrence of the flood of 1837, held by many

to be impossible, for reasons already stated; more mature reflection convinced me that effectual security would be best atttained by designing the work to withstand any extraordinary danger arising from causes beyond the possibility of the Victoria Bridge averting, or in fact to treat the subject irrespective of the Bridge and its influences. Acting on this determination therefore, and with the assumption that what had once happened might occur again, the flood-height of 1837 was assumed as the level of high water, and the crown of the embankment placed 6½ feet above; that this was a correct conclusion is proved by the water in the river during the present spring shove, having exceeded the height of 1837 by 1 foot, or reaching within 5½ feet of the limit fixed on as insuring safety. This point having been established, my attention was then directed to the most proper form of cross section to combine space with economy of material and construction, at the same time furnishing a water-tight embankment when subjected to a pressure of 26 feet head; keeping in view likewise the best arrangement for the future erection of buildings, with their foundations resting on the original consolidated bed of the river, and sluice or tail race connections at the least possible expense. With reference to the first requirement mentioned, it was evident that in order to afford facilities for railway operations, not less than four distinct tracks would be required, for siding convenience and shunting movements, in order to conduct successfully the enormous inward and outward traffic which might reasonably be supposed to result from the operations of so many manufacturing establishments as the gradual development of the project would call into being. 57 feet was allotted for this purpose, together with 37 feet for a cart road and 6 feet additional for a footwalk, making in all a width of 100 feet between the front line of the embankment and the rear wall of the mills; a second road, 30 feet wide, was also determined on, as the space to exist between the front wall of the buildings and the edge of the dock, to furnish facilities for placing gangways from vessels and temporarily depositing goods or flour, with access from the one in rear, at intervals of 600 feet, by lateral streets 30 feet wide; the mill lots bounded by the streets so described are each 150 square, being nearly double the area of those at the foot of the Lachine Canal, now found too contracted for carrying on an ex-

tensive business. Having thus briefly described the surface arrangements, we now come to those for the vertical. The foot-walk of six feet in width is carried along the outer side of the embankment and raised to the height of 29 feet above summer water level, from whence it slopes on the river side down to the bed of the stream, with an inclination of $1\frac{1}{2}$ to 1, and protected against the cutting action of the current and abrasion of the ice by means of a rip-rap wall; the remaining side dropping down 3 feet to the level of the cart road, 37 feet in width, which in its turn drops down three feet more to the level of the railway bed; this level being carried to the rear wall of the buildings, from whence it descends to low water level. The dock wall in front will be of solid and substantial masonry, starting from the rock or a secure foundation, and carried up to the height of three feet above the level of water in the basin, and backed up with puddle, which will also slope down to summer level. In the void so left, between the puddle and the outer embankment, the mills will be placed, with the foundation walls resting on the original bed of the river or solid rock, and rendering little excavation of new material necessary. The sluices through the dock walls, with the regulating gates as well as the tail races underneath the embankment, in rear of the mills, will be built in place, during the progress of the work, at proper intervals so as to be in readiness when required.

The mode in which the work will be carried out, so as to combine despatch with economy of construction, will be described when we come to treat of the inner docks.

The extent of the reservoir formed by the embankment just described, is about 152 imperial acres of water surface, raised to a height of 26 feet above the summer level of the present harbor, or to a height corresponding with the existing mill basin at the foot of the Lachine Canal, and retained at that level by means of the feeder to be presently mentioned. From this basin the water will discharge into the river through the mill sluices, and when used to its full extent will furnish a power equivalent to 32,618 horses, giving motion to the machinery of 44 large flouring mills and 84 smaller establishments for miscellaneous manufactures, situated at the lower end of the dock. The cross sectional fea-

tures of this side will be similar in every respect to those described for the outer and remaining portions of the surrounding embankment, if we except the greatly increased width of the void space for the buildings, brought also to the height of low water; the flumes constituting the head or tail races, and carrying the streets overhead, will be constructed only as the lots bordering thereon are disposed of and brought into use, spreading this portion of expenditure over a period subsequent to the time when a revenue will flow into the Company's exchequer.

Access from the harbor below will be had by means of a ship lock of sufficient dimensions to enable the largest ocean steamers, which the increased trade of the country will in future demand, and the improved navigation of the river between Montreal and Quebec will in all probability ever admit to this port, to ascend into the docks and place themselves alongside of the warehouses and manufactories there existing, for the purpose of discharging inward cargoes and receiving the outward ones. This lock will be provided with double gates at each end to guard against the danger to the dock of vessels striking and breaking any one of them, for should this casualty occur, the pair immediately in front will act as guard gates, thus insuring the dock against so serious and fatal an accident as would result from the presence of the ordinary single pair under such circumstances; they are to be built in a curved form of boiler plate iron to enable them to resist successfully the enormous pressure due to a lift of 26 feet, and will be moved by means of water wheels. The distance between the inner gates will be 500 feet, with a width of chamber of 75 feet, corresponding to the Sault St. Mary Lock at the outlet of Lake Superior; this chamber will be divided by an intermediate set of gates for the use of ordinary river and ocean vessels, thereby economising the water for the lockages.

The width proposed for the lock is greater than will ever probably be required for transatlantic vessels coming to this port; but, keeping in view the future enlargement of the St. Lawrence canals, or the construction of the Ottawa and Lake Huron Canal, for the passage of large side-paddle steamers navigating the upper lakes, it will form the eastern link in the chain of enlarged inland navigation, as the existing Sault St. Mary Lock now furnishes the

western one, more especially as this width can be given when first constructed for a sum bearing a very small proportion to the entire cost, but ever afterwards rendered impossible. To establish more fully the importance of this enlarged scale being adopted at this governing point would require too much space for the arguments necessary for so doing, and must therefore be deferred to the time when the entire question of future canal enlargement will be considered in its bearing and influence on the project now under discussion.

To give facilities for repairing and building vessels, a dry dock, 550 feet in length by 100 feet in width will be placed immediately alongside of the lock, and capable of receiving the largest steamers visiting Montreal, or two smaller ones at the same time by the use of intermediate gates.

In addition to the hydraulic dock so described four inner docks are to be formed, with the excavation going towards making up the embankment of the outer one. They will occupy the ground enclosed by the Grand Trunk Railway, Wellington Street, the Lachine Canal, and River St. Lawrence, running from the canal parallel with Wellington Street and with each other, possessing a width of 190 feet, with a depth of water sufficiently great to permit ocean vessels when loaded to occupy berths in them, placed 460 feet apart, furnishing space for a double row of warehouse lots, 150 feet deep each, and abutting on the docks, leaving an intermediate street of 100 feet in depth for the accommodation of a cart road and six railway lines. The remaining 60 feet will be appropriated to two streets, 30 feet each, between the front edge of the dock walls and the warehouses; this arrangement furnishes sites for 93 warehouse lots, 150 feet square, provided with inland, oceanic, rail and cart connections. The junction of those docks with the hydraulic one will be had by removing the existing waste weir near Grant, Hall & Co.'s mill, and constructing a channel 75 feet in width with a similar draft of water as the docks, through which the vessels will pass from the main basin to a second or distributing reservoir on the inside, formed by an enlargement of the existing canal basin. This inner reservoir will contain a surface of about 27½ acres, and affords space for vessels of any length to swing into the docks abutting on it, or otherwise manœuvre, as may be

necessary. A large volume of water will also flow into the hydraulic basin through a channel placed at the upper end of the inner docks, and crossed at different points by means of fixed bridges, as it is not intended that vessels shall navigate this channel, so as to obviate the use of swing bridges. The exact position of this feeder will depend on the following consideration: In the event of furnishing water power for all those warehouses, to such extent as will drive wheat elevators, with machinery for moving and lifting goods from one story to another of the buildings, then the channel will be placed near the end of the docks, bordering on the Lachine canal, or immediately before the regulating gates to be presently noticed; this will allow the water from the wheels to be carried by means of covered tail races underneath the streets containing the sidings, in the direction of the Grand Trunk Railway, to the open tail race running towards the Victoria Bridge, and discharging into the river at the outer end of the north abutment. But, on the other hand, should it be thought not desirable to furnish facilities of this nature, from the expense of constructing tail races, or for any other reason, then the channel will be placed at the end of the docks nearest the Grand Trunk Station, as one fixed bridge, 20 feet wide, will be sufficient for carrying a single track across, to afterwards connect with the different sidings for each section or double row of lots; this will at the same time neutralize the action of the currents in the docks and facilitate the movement of vessels. The principal use of this channel is to convey water into the main as well as inner docks during the season of the year the water is withdrawn from the Lachine Canal, for making necessary repairs. Now as the period selected for this purpose is in the spring, before the navigation opens, and consequently no vessels require to move from the main dock into the inner ones, the gates in the connecting channel near Grant, Hall & Co's mills will be closed against the water in the main basin, as well as those at the lower end of the two inner docks, effectually severing the connection with the Lachine Canal, and at the same time forcing the entire volume of water supplied by the proposed canal around in the upper channel to keep up the supply for the new mills and factories under the jurisdiction of the Company; but should the Dock Company require to perform a like service to

their own basins or works, the closing of the reverse gates to those previously referred to, will enable them to do so, either from the whole system or any individual dock, leaving the remaining ones and the Lachine Canal in full operation.

Those gates, as shewn on the enlarged plan, consist of two leaves each; it is proposed, however, in order to accommodate the cart and passenger traffic resulting from the business of the warehouses, to place a light iron swing bridge over the entrance of each inner dock, supported on a pier placed in the centre. Smaller gates working each way will be attached to the sides of the piers and the contiguous dock walls, and fitting into recesses prepared for them when not in use. A very important purpose answered by these gates will be the facilities afforded for shutting off the water from the respective basins, to admit of the inner side retaining walls being built whenever required.

The land to be occupied by these proposed improvements is owned by the Provincial Government, the Grand Trunk Railway, and James Hodges, Esq.; the whole space being now unoccupied, if we except a few inferior shanties of little worth, and three freight sheds belonging to the Grand Trunk Company. In a second arrangement, it is proposed to extend the docks to the limits of the government property only, causing it to fulfil the purpose for which it was originally acquired, but with the plan so arranged as to admit of future extension to the full extent of the first project.

An important feature, and one entitled to much consideration, is the relative widths to be given the docks, building lots, &c., for enabling them to fulfil the greatest amount of service in their respective capacities. In the first sketch prepared for this part of the scheme, the docks were assumed at 250 feet in width, so that a vessel 75 feet beam might pass two others of the same dimensions while stationary on each side of the dock, and also to possess space sufficiently great to enable her to turn around, and leave the dock bow first. This room was acquired, however, at the expense of the cart roads between the railway tracks, and a diminution of the roads in front of the warehouses; the remaining space, occupied by the railway and building reserves, being in my opinion susceptible of no reduction, if the full benefit to arise from their mutual

relation to each other were to be realised. A second arrangement was prepared, and now submitted, with docks reduced to 190 feet in width, but with cart roads and an increased breadth of wharfage space, for the convenience of gangways, &c., &c. In this plan it is evident that the conditions laid down, as necessary for the full and efficient movement of vessels, is not regarded, and therefore must be looked upon in an unfavourable light; it is true they could turn by proceeding to the cross channel at the upper end of the docks, in the event of being placed in that locality, but with the danger of having their movements impeded by the current setting into them, to say nothing of the time lost, greater perhaps than to have in the first place backed out stern first, or dropped down gently with the current. A modification of the two sketches will probably be an improvement: that is, to re-establish the docks at 250 feet in width, and increase the wharfage space in front of the warehouses to 40 feet for cart purposes if required, as well as for its own legitimate duty; the additional space so furnished to be obtained by sacrificing the cart roads of the second plan, and taking a portion of the increased width so given off the warehouse lots, 170 feet deep, abutting on Wellington Street, more especially as from their position they are deprived of railway connection and can be made less in depth without material injury.

It may perhaps be thought that too much space has been occupied in the present report with this branch of the subject, but on reflection it is thought the Committee will agree with the writer, in respect to the great importance of a judicious and well digested plan, in which the different parts will be in harmony with each other, this being moreover not so much an engineering as a commercial or nautical question, and as such entitled to the consideration and consequent decision of the Committee itself.

With the foregoing remarks, descriptive of the general features of the scheme, it may be proper to offer a few additional observations, with the view of shewing the advantageous and economical mode in which the work can be carried into execution.

It has already been stated that the surrounding embankment of the outer or main basin will be made to a great extent by means of the excavation arising from the inner reservoir and docks; the advantage to be gained in combining the different

works into one system of construction is that a portion is formed by the execution of the remainder, and uniting economy with the most efficient means of handling and transporting the amount of material necessary for attaining this end. The most feasible plan of operation for the purpose in view will be to form a tramway at the foot of the slope of the outer embankment, resting at intervals on cribs of about ten feet square, with intervening tressels for supporting the stringers carrying the railway track, by means of which the earth excavated from the inner basins can be conveyed and dumped from side-tip cars into still water on the inner side, the tramway preventing the current rushing past on the river side washing away the earth so deposited; with the rising of the new embankment above the surface of summer water level the railway track can be gradually moved in the direction of the dock wall, and this point reached, preparations for commencing the masonry can be made. In order to accomplish this important part of the work with facility and economy, light pontoon scows made in convenient lengths, of 10 or 12 feet in width, will be arranged in a line several hundred feet in length, placed sufficiently far from the embankment to form the side of a coffer dam, with the embankment acting as the other, and united at the ends of each section. The scows will be so constructed as to admit of a puddle chamber, with the necessary sheet piling, being formed on the inner side to render the dam secure and water-tight; from the space so enclosed the water will be removed by means of a centrifugal pump, worked by an engine placed on one of the scows. This being completed, the staging for carrying the travellers will be erected sufficiently high to surmount the dock wall when built, and of such width as will encompass it as well as a railway track immediately behind. On the removal of the deposit of sand, gravel, and boulders to the solid rock, the masonry can be commenced by lowering down large blocks of stones from the cars on the adjoining track, by means of the travellers, with the utmost despatch, and continued until the wall reaches the surface of the water throughout the whole length of the section laid bare by pumping; this point being reached, the pumping of leakage water will cease, and preparations be made for enclosing an additional length with the same pontoons, which being rapidly accomplished,

a second section can be laid dry, and the same process of building repeated as before. While this is being done, and the masonry gradually rising to the water's surface, that section previously brought to the same level has been also fast increasing in height, together with the embankment behind it, and lifting the stone track simultaneously with the other two. The process of conveying blocks of stone and depositing them in the wall without any hoisting being required will hasten the completion of the masonry, and at the same time allow of the work being done at the least possible expense. By some such arrangement as this, great progress can be made in one season, and the work left in such position during the winter as not to be injured by the ice; indeed the outer section of the embankment can be raised to its full height during the winter as well as if done in any other season of the year. The dock wall sluices, gates, and tail races will be put in their respective positions during the progress of the work; the latter can be made of flatted cedar, placed below the surface of the water, and therefore beyond all atmospheric influences and consequent decay.

In the foregoing description I have endeavoured to show the extent to which the requirements of the Committee have been complied with, in so far as relates to increased harbor accommodation, combining facilities for manufacturing and warehousing, as well as connection of rail or inward with oceanic or outward traffic. It shows, in fact, an increase of 5 miles of dockage when carried out to its full extent, with numerous mills and warehouses provided with ample motive power, and space bordering thereon, into which cars loaded with cereals or general produce can discharge with the utmost facility during the whole period of the year, receiving return loads of flour or other freight for transport to Portland, Boston, New York, or the West; while during the season of navigation the internal and foreign craft can exchange similar cargoes with the greatest despatch for a minimum cost.

With the above remarks on the dock arrangement, we now come to the consideration of the feeder or canal by which it is proposed to furnish the water for the useful purpose described.

In the course of the St. Lawrence from Prescott to Montreal, various rapids or falls occur, interrupting the navigation of the river, but surmounted by the different canals at those points; the

principal obstruction of those adverted to, exists in the Lachine rapids within the immediate neighbourhood of the city, where the whole volume of water in the St. Lawrence tumbles down a rocky bed for the distance of three-fourths of a mile, furnishing but a narrow channel of ten feet draft of water for descending vessels to shoot through. From a point about one mile above the rapid, to the level of the Montreal harbor, there exists a fall due to the declivity of the river, of thirty-nine feet, and which can be made available in connection with the scheme we are now describing. To make the subject more clearly understood by those not acquainted with the locality, it may be well to go over ground not otherwise requisite, as all the members of the Committee are perfectly conversant with its features.

Prior to the completion of the Lachine canal, a work executed by the Provincial Government at a cost of $2,000,000, for enabling vessels navigating the river, to pass this rapid, the city of Montreal was without manufacturing facilities, if we might except a couple of windmills, the walls of which are now standing as monuments to indicate the progress a few years have brought to pass. With an enormous power, equivalent to at least four and a half millions of horses, running to waste in the vicinity of the city, the good citizens had apparently the utmost reluctance to avail themselves of its services, evidently placing more faith in the efficiency of the windmills adverted to, than in the more reliable and powerful agent at their door. A great change, however, was at hand, and destined to revolutionize the primitive ideas entertained respecting the utility of the motive power advocated and used. On the completion of the Lachine canal, immediate steps were taken by several enterprising gentlemen, to turn its surplus water to useful purposes, and with what success the numerous mills, factories and machine shops which shortly sprung into existence at the different points along the canal where the power was available, will best answer. Indeed it can not be claiming too much to assert that the city stands largely indebted to them for its present material and commercial prosperity, converting it, as they do, into the grand manufacturing centre of the entire Province and giving profitable employment to several thousand mechanics.

The power thus furnished has, however, reached its limit, and until some further steps are taken to draw another instalment from the inexhaustible source within our reach, now every day called for, no further progress can be expected in a manufacturing point of view and which must re-act most injuriously on the general interests of Montreal.

In the docks previously described, we have endeavoured to make suitable arrangements for using the water when furnished; the point now to be considered is the most feasible method of accomplishing the purpose for which they were designed by introducing a sufficient amount of water into them. This can be done in two ways, either by enlarging the Lachine Canal or by the construction of an independent one. The first mentioned project is surrounded by so many difficulties and obstructions as practically to be beyond the limits of possibility, and therefore not to be entertained; it is true, by widening the "rock cut," a small additional amount of water might be obtained, but utterly insufficient for the purpose in view. As before stated, this canal is the property of the government, built expressly for navigation purposes and always keeping that object primarily in view, leaving but the surplus over and above that required for the legitimate canal working, as available for other useful objects, and now in use to its full extent. The sectional area of the canal is about one thousand square feet, with a current moving at the rate of one and a quarter miles an hour; the width on bottom being eighty feet, slope of sides two to one; ten feet deep and eight and one-half miles in length; having embankments on each side for the greater part of its entire length, with five locks under a head of forty-three feet nine inches. Now in order to gain the amount of water necessary for our purpose, the width of the canal would require to be increased to a very great extent by moving the embankments farther apart, and only attainable by stopping the entire navigation, as well as the manufactories depending on the water now furnished, for at least two years, involving the ruin of both, and therefore placing this source of supply entirely out of the question. Fortunately, however, the second mode is subject to no such objections, at the same time eminently practicable, as it can be accomplished within a reasonable period, at a less expense when viewed in connection with the

whole scheme, and at the same time disposing of the water works tail race difficulty.

From a point about one mile above the Lachine Rapid, the Water Works aqueduct conveys a sufficient supply for furnishing the city, and for driving occasionally two large breast wheels for forcing the water so supplied up into the reservoir on the side of the mountain, from whence it is distributed throughout the city. The line of this aqueduct is nearly parallel with the course of the river, but placed back from it about three-fourths of a mile. The country intervening between the two and the city is nearly level, of alluvial or drift formation, and remarkably facile for the construction of the proposed new canal, which will leave the inner dock near Wellington Street, and proceed in the direction of the wheel house, occupying land owned by the Corporation, acquired for tail race purposes, but since abandoned. From a point opposite the wheel house, it will follow the course of the present aqueduct to its junction with the St. Lawrence, and with the excavation from the prism of the canal at the upper end, made to form an outer embankment, will proceed up the river margin for such distance as will yield two feet of water additional to that obtained at the entrance into the river.

The width on bottom of this new canal will be one hundred and sixty feet, but with sufficient space retained to admit of three hundred feet in width being given,when the requirements of commerce and manufactures demand an additional quantity of water. To give facilities for this enlargement, the embankments of the canal will be placed at the full distance apart, so that the ultimate width can be obtained, without disturbing them, by the removal of the intervening excavation. (See Sec. No. 3.)

The depth of water in the canal will be fourteen feet, and move with a velocity of two miles an hour. In assuming the above depth as necessary, it may be remarked that although in excess of that recommended for the Georgian Bay Canal by one foot, it has been thought desirable to adopt it in order to cover any loss which might arise during the winter months, when the surface ice occupies a certain amount of sectional area, and thereby retards the full flow of the current; this depth, or even more, can be given without much additional expense, for the greater part of the dis-

tance where embankments occur. The entire length of the canal, from the point of departure at the river to its junction with the dock at Wellington Street, is about 5¼ miles, being but a fraction in excess of an air line between the same points. The increased sectional area which will be given the prism of the canal below the second lock, to be presently mentioned, can be obtained by deepening instead of widening, as on the remaining portion above, for the two-fold purpose of economising land which is valuable on this section, and likewise to admit of ocean vessels reaching the manufacturing establishments to exist at Lock No. 2.

We have before stated the fall at the Montreal dock to be twenty-six feet, and that the entire fall, with the two feet gained at the upper end, amounts to forty-one feet; now, deducting the loss of head due to the velocity of a current in the canal of two miles an hour, we have still left about twelve feet to be made use of before coming into the main dock. The point selected as the site for the use of this power is in the neighbourhood of the Water Works wheel house. Here there will be a lock provided with double gates, and an intermediate pair, as in the case of the large lock leading up into the hydraulic dock; by means of the inner gates, vessels four hundred feet in length, seventy-five feet beam, fourteen feet draft of water, can ascend into the upper reach; or, if using the intermediate gates, the ordinary steamers and vessels now navigating the St. Lawrence may pass with half the amount of water otherwise used. These gates will be of boiler plate, curved to the pressure, and worked by water power. Their useful purpose will be the same as described for those of Lock No. 1, and taken in connection with the stop gates at the entrance of each head race carrying the water to the various mills, will do away with the necessity of a third or guard lock at the upper end of the canal, together with very extensive sluice arrangements at the same point for passing the water; great economy in first construction as well as subsequent working will thus be obtained.

The land on each side of the lock can be purchased by the Company and laid off in mill sites to the number of 93, each 150 feet square, with an aggregate power, when in full operation, of 18,000 horses. The head races will be so arranged as to admit the water being withdrawn from any individual one for repairs

without interfering with the others. Streets, forty feet in width, will intervene between the building reserves and these races. The tail races, for conveying the water from the mill wheel sluices into the canal below the lock, will be of such dimensions as to carry it freely, and of sufficient depth to enable vessels to ascend and place themselves along side of the factories. Streets seventy feet in width, to admit of double lines of railway and cart roads, will exist between the tail races and mills, with connections at different points with those bordering on the head races previously adverted to.

Bridges to form junctions with the different lines of manufactories will be placed across the various races as shewn on the plan.

With the foregoing arrangement, the establishments existing at this locality will be in possession of extensive space, motive power, railway, cart and craft connections, and on the deepening of the lower reach of the canal, with oceanic as well, all of which, taken in conjunction with the cheapness of building lots for the houses of artizans and workmen employed in the factories; as well as being beyond the pale of city taxation, situated in an eminently healthy section of country, and at the same time bordering on the most flourishing seaport city of British America, form altogether such advantages, and yield so many facilities for the employment of capital, as no other site on this continent can equal or even approach.

Several mechanical structures on this part of the work require a passing notice; the most important being the pontoon bridge for carrying the Grand Trunk Railway over the new canal.

The various engineering difficulties which render it impossible to make use of a similar mode of crossing, to that adopted at the Lachine Canal, need not at this time be discussed; a short description of the plan proposed will therefore suffice.

The pontoon will be so arranged as to float itself on the surface of the water, and of sufficient width to carry a carriage road in addition to the railway. One end will fit in a recess on the river side of the canal, and attached to it by means of a strong pivot connection, so arranged as to admit of the whole pontoon swinging around upon it as a centre, and fitting closely into the recess to

prevent vessels coming in contact with it when passing through; as in this position it is open, and furnishes a space of seventy-five feet in width of canal for navigable purposes. When in place, the outer end will rest over a pier in the centre of the canal, upon which the remaining or fixed portion of the bridge is supported. It will be so arranged as to admit of a vertical movement of two feet, according to the level of water in the canal, and permit trains passing over under such conditions, at the same time susceptible of a rotatory movement itself. When the water in the canal falls below a certain point, the pontoon becomes fixed on the pier and abutment supports, floating no longer, but converted into a compound girder bridge, strengthened by means of a strong open "Warren Truss" underneath its bottom, provided for such contingency; this pontoon will be opened and closed by the action of a water wheel with the utmost facility, as its travelling end will have to describe but a small portion of the circle in so doing. The waste weir for regulating the height of water in this reach, being convenient to the wheel, it will be at all times within the power of the person in charge to keep the level favourable for the proper action of the pontoon. The tail race from the wheel, as well as the waste water from the canal, will be conducted to the river St. Pierre, which is within a short distance of both.

A syphon culvert, for carrying the water of this stream underneath the canal, will also have to be constructed, either of wood, stone, or iron, as may be determined on, and likewise to provide for the waste water from the Montreal wheel house, whenever the water is withdrawn from the new canal for repairs, or for other purposes.

A swing bridge, in line of the lower Lachine Road, will be built at the upper end of the canal for the accommodation of ordinary traffic; it can be worked with a water wheel under the two feet head gained at that place, or by manual labour. Stop gates will also be provided at this point, so that the water can be withdrawn entirely from the canal at any time for future enlargement or repairs; they will, when not in use, fit in recesses provided for the purpose on the sides of the piers supporting the bridge.

A feeder can be thrown into the St. Gabriel level of the Lachine Canal, where a further supply of water is now urgently required,

used for mill purposes at that lock, and flowing from thence into the Company's main dock below. The quantity for this purpose can be taken from the western head race of Lock No. 2, and carried under the Water Works aqueduct by means of a rod culvert, to be put in during the time the water is withdrawn by the Corporation for necessary repairs, &c.

A Boulevard of one hundred and twenty feet in width, extending the whole length of the canal, will be placed on its western side and furnish a delightful drive or promenade for the citizens or strangers visiting Montreal, as by this route they will be enabled to inspect all the extensive and varied establishments in connection with the Company's works, returning to the city by the Lower or Upper Lachine roads; it will be graded forty feet in width for a carriage road, with foot walks of fifteen feet wide on each side, the remaining portion being planted with shade trees and shrubbery, having the drainage exterior, and concealed from view. Bordering on this boulevard will be the land acquired by the Company, lying between their own canal and the Corporation aqueduct; this land will be laid off into villa lots, forming delightful summer residences for families, being out of the heat, dust, and turmoil of the city, in the immediate and healthy neighbourhood of the rapids, but at the same time within a few moments drive of Montreal. The lands owned by proprietors on the eastern side of the canal will be much enhanced in value, and can be disposed of in small lots for similar purposes.

Having developed the main features of the proposed project to the foregoing extent, it is now proposed to take up the two remaining elements: the Grand Trunk City Terminus, with the Water Works Tail Race, and amalgamate them in the general scheme in a manner alike advantageous to all.

Perhaps no subject, involving so much the general interests of Montreal, has ever been clothed with local prejudices or sectional proclivities to the same extent as the question of the city terminus, and until taken in hands by the present Company, was there the slightest chance of the problem being solved, or of the public reaping the advantages of that solution. From the period of the opening up of the Grand Trunk Railway to the present time, this important oceanic and railway terminal station has been almost

practically deprived of the facilities necessary for conducting the business inaugurated by the Lake St. Peter improvements and railway connections with the Upper Province and far west, in consequence of a distance of nearly two miles intervening between the railway terminus and the harbor, over which all freight had to be transported by horse traction, on inferior and frequently nearly impassable roads, involving great expenditure of money and time; neither has the local business of the city been more highly favoured, but subject to a like cost and annoyance. All were therefore agreed as to the necessity of greater accommodation, but sadly at variance as to the how and where. This is neither the fitting time or place to review the combats fought respecting the rival advantages of the Lachine Depot, Haymarket and Chaboillez Squares, foot of McGill Street, College Grounds, Champ de Mars, Hochelaga, and numerous other localities, as sites for the station, or whether the entire commerce of the Province would not be paralized and ruined by allowing a railway swing bridge to be placed over a canal lock. The Committee no doubt remember the discussions which took place through the public journals and at meetings of the Board of Trade, with the strong and conclusive reasons adduced by partizans in favour of each locality over and above all competing ones, until the able report of Mr. Shanly, addressed to the Harbor Commissioners, narrowed the debatable ground down to the foot of McGill Street. With that gentleman's arguments in reference to the proposed site I perfectly concurred, but took exception to his line of approach and harbor connection, with several other minor points which in my opinion militated against the project in its individual characteristics, but obviated or lost sight of in consequence of the present junction of the scheme with the general one of harbor extension, on a scale not entertained at the period of Mr. Shanly's report.

During the time of this wrangling and discussion, however, the trade of the city was saddled with an annual charge of over one hundred thousand dollars, a sum sufficiently great to accomplish the purpose sought in two years, but what was of still greater consequence, the railway traffic was being gradually diverted into other channels from which it would be difficult to regain it. In this posture of affairs, from the inability of the Grand Trunk

Railway Company to settle it, the question is taken hold of by the Montreal Terminus Company, who propose to build the road into the city, with the necessary station buildings at the foot of McGill Street.

In carrying out the project of a union of the rail at Point St. Charles with the city terminus on the site indicated, so as to prove beneficial to the various existing interests along the route, and at the same time keeping in view the ultimate union of the scheme with that of the docks previously mentioned, it will be necessary to widen Mill Street to the extent of eighty feet, leaving forty feet contiguous to the mills for cart traffic, and devoting the remaining forty feet to the accommodation of one main track and two lines of siding for the crossing of trains and the benefit of the mills and factories existing at the foot of the canal. The main line for eastern trains will leave the Grand Trunk Railway near the Victoria Bridge embankment, and sweeping around with a radius of 800 feet, join the city line near St. Etienne Street; while that for western trains will leave the present railway at a point nearly central between Wellington Street and the existing passenger station, curving from thence with 800 feet radius, and forming a junction with the Mill Street line when produced in the direction of the Grand Trunk Railway. By means of this double connection, trains arriving and departing, either in an easterly or westerly direction, can do so with the utmost facility, having the engines in all cases in advance of the trains, without the trouble and delay of shunting. These tracks, up to Mill Street, will occupy a portion of the space reserved for railway purposes in connection with the warehouse lots of the dock scheme, and of which system they will constitute a part.

The tail race from the waste weir near Grant, Hall and Co.'s mill, will be crossed by means of an iron girder or temporary wooden bridge, as may be determined, of 45 feet span, until such time as the dock arrangement is carried out, when the fixed bridge will be replaced by a swinging one of 75 feet span, to admit of vessels passing to and from the various docks. One of the abutments of the temporary bridge will, however, be built in a permanent manner, and in such position as to form part of the main dock wall of the connecting channel when constructed; the re-

maining abutment to be taken down, and its material made use of in building the opposite dock wall. The position of this bridge will be such as to admit of its being used up to the completion of the swing bridge, so that no interruption to the city traffic will ensue, and placed sufficiently high to carry the rail level above the highest flood of the river St. Lawrence. A second, but more expensive arrangement in the first instance, will be to place both abutments in the line of the respective dock walls, furnishing a total span of 75 feet, with a temporary pier in the centre to sustain the superstructure of the bridge, if built on a cheap principle, until such time as the erection of the permanent iron swing bridge, of the entire span, will permit the removal of the present proposed structure.

From this place, as before stated, the line will proceed in a straight direction, on a level grade, along the widened portion of Mill Street to a point in the river opposite the lower end of Lock No. 2 of the Lachine Canal, from thence sweeping around with a curve of 500 or 600 feet radius, as may be determined, to the swing bridge placed over the upper entrance of the Guard Lock, in a direct line with McGill Street, which it reaches by means of a series of girder spans placed between the lock and the revetment wall of Common Street. At this point the rail will be 3 feet above the coping of the revetment wall, or on the same line with the river flood in April last, and branching off into different sidings will proceed along McGill Street, raised to a like height, and thus placed beyond the injurious action of inundations in time to come.

The swing bridge carrying the railway over the canal will be the largest structure of its kind in the world, and requires a more detailed description than the remaining portion of the work. The actual width of the canal at the point of crossing is 58 feet, but from the necessity of providing a margin of at least 10 feet between the bridge piers and the canal on each side, together with the pier requirements, the clear span over the navigation will be increased to 80 feet, making the total length of the bridge 184 feet.

It will be supported in the centre and revolve with rollers on a circular pier of masonry, twenty feet in diameter, built on the

south side of the canal, at the distance of ten feet from the front edge of the coping, and placed at such height as to furnish 8½ feet of clear headway between the under side of the bridge and the coping, and 15 feet for the remaining span. At this level it will carry the rail above high water, at the same time swing clear of all obstructions, and consequently will not impede or interfere with the working of the lock gates or canal. Another advantage gained by the proposed bridge is that of swinging around the entire circle instead of but half way, as is the case with ordinary moveable bridges. The importance of this will be better understood when it is explained that with the style of swing bridge usually adopted the railway traffic would be interrupted from the time the vessel entered the lock up to the period of her leaving it, whereas, on the other hand, with the plan now proposed, the bridge could be in use to the time of opening the upper lock gates for the vessel's exit; thus enabling trains to arrive and depart on time to a greater extent than would otherwise be permitted, and form their various connections with as much facility as could reasonably be expected.

When not in use, the bridge will be swung to, and in that position lie parallel with the canal and lock, but from its height and distance back from the inner line of the coping, it will be entirely beyond all interference with the canal navigation or access to the lock. Two small piers for the ends of the bridge to rest on when open will be constructed, as well as a guard embankment for the purpose of shielding the bridge from moving ice during the time of high water.

The bridge itself will be constructed of boiler plate iron, stiffened by means of angle and tee bars, in the form of two side ribs, each built on the tubular principle, and of the following dimensions: length, 184 feet; depth in centre or over bearing pier, 8 feet; depth at extreme ends, 5 feet; width, 2½ feet; straight on bottom and parabolic on top; placed 18 feet apart, and connected transversely on the bottom, at distances of 3½ feet, by keelsons and gussets for the support of the longitudinal timbers 10″ × 12″ to carry the rail.

The bridge will be trussed at different points on each side by double suspension bars or wire cables, passing over cast iron sad-

dles attached to the top of the side ribs, over the centre pier, and raised 15 feet high. These trusses will modify the various strains at the central bearing, resulting from the leverage exerted by the weight and span of the structure when unsupported at the ends. The entire bridge being equally balanced on the bearing pier and friction rollers, will be readily swung by manual power, or with the aid of a small water wheel if necessary.

The viaduct for carrying the rail from the swing bridge to the revetment wall at the foot of McGill Street, will consist of four spans of 45 feet each, with ordinary girders, having a clear headway underneath of 8 feet, for cart traffic between the city, canal, and harbor, with the exception of the span nearest the city, where the headway will be increased to eleven feet to admit of cabs and omnibuses passing underneath in going to the guard lock for passengers by the Upper Canada steamers. By adopting the proposed viaduct instead of a solid approach, as was originally proposed, much valuable space is retained which would otherwise be occupied by the embankment, and at the same time will admit of traffic to and fro as at present; while, on the other hand, had the solid approach been carried out, it would have effectually severed the harbor and guard lock from the remaining portion of the Lachine Canal, in so far as the present travelled route is followed.

The piers of the viaduct will be built of heavy rock-face ashlar, with chiselled margins and pilasters, which together with the light iron girders will present a more pleasing and ornamented feature than the earth embankment with its sloping sides, while at the same time not much more expensive.

The extension of the tail races from the various mills can easily be effected, as well as the construction of additional ones for the proposed new mill sites; the work will be of so simple a character as to require no further notice here. A few box culverts, for surface drainage, will also be required.

With the above description of the proposed mode of effecting a union of Point St. Charles with the City proper, I now proceed to state what in my opinion will be the necessary amount of accommodation for station and siding purposes, to supply the present wants of the trade, as well as any future requirements ever likely to arise. Fortunately, for this purpose, there exists on each side

of McGill Street, between Common Street in front and St. Ann's Market in rear, a large space of open ground, covered in part by a few wooden sheds of little value, if we except one building, and conveniently situated, both with reference to the private warehouses of the city and the harbor. At the present time it is proposed to appropriate the strip of ground bounded by Grey Nun, McGill, Common, and Wellington Streets, for the erection of the inward freight depôt, a part of which can be used temporarily as a passenger station, until such time as the permanent structure for that purpose is erected. For future extension, and as furnishing the most convenient site for the passenger station, it would be most desirable for the Company to acquire the additional space existing between the strip mentioned and William Street, as it will admit of the main depôt being placed as far into the business part of the city as possible, and convenient of access from all quarters. The space of land, so acquired, will be about 120 feet deep on Common Street, 970 feet in length, but converging to a point in the direction of William Street, where the depth will be reduced to 89 feet, making an average width of 105 feet, with a superficial area of 101,850 square feet.

The station buildings, to eventually extend the entire length, will have a breadth of 80 feet, with a platform of 10 feet on the side facing Grey Nun Street, and placed sufficiently far back to increase the width of this street from 44 to 70 feet for the accommodation of the cart traffic with the station. This plan necessitates the closing of the portions of Wellington and Youville Streets between McGill and Grey Nun Streets. As there is, however, but a small amount of traffic over the streets to be so taken, and from the far greater facilities afforded to ordinary traffic by the widening of Grey Nun Street, making it in fact one of the principal thoroughfares for cartage between the station, city, and harbor, the advantages to be reaped by the public and business community in the carrying out of the plan will be evident. The railway lines, three in number, in connection with the inward freight depôt, will be placed on the McGill Street side of the station, and together with the buildings will occupy a portion of that street.

For the convenience of classification, and ready access to the present harbor, it is proposed to locate the *outward freight* depôt

on the east side of McGill Street, on a portion of the vacant space lying between Common Street in front and Youville Street in the rear, but at the same time acquiring a sufficient amount of land, between this point and St. Ann's Market, to extend the station buildings as far as Foundling Street, whenever required. The building will be 820 feet in length, when carried out to its full extent, with a width of 80 feet, and a platform in rear of 10 feet wide. The railway sidings connecting with this portion of the general terminal station will be three in number, and placed on McGill Street, parallel with those previously described, and connecting with them at different points, so that ready access from each other may be had for engines and trains.

Immediately in rear of the outward freight depôt, a new street, 70 feet in width, will be opened up, running the entire length of the station, or connecting Common Street in front with Youville Street intermediate, and Foundling Street, near St. Anne's Market, in rear, and will admit of carts and carriages approaching the station from the harbor and the city with the utmost facility, without interfering or coming in contact with the railway traffic on McGill Street. The amount of land required for terminal purposes, when the plan is carried out, will be as follows:

West side of McGill Street.			
Private proprietors.....ft.	93,204		
Corporation (Youville and Wellington Streets).....	10,860		
		104,064	
East side of McGill Street.			
Private proprietors	52,441		
Grey Nunnery.....	93,100		
Corporation (Youville Street).....	9,000		
		154,541	
			258,605
Land taken from Corporation and appropriated to station purposes.....			19,860
Land belonging to Company given Corporation to			

widen Grey Nun, College, and Foundling Streets, and in opening up new street.....	86,510
Showing an excess of land given the Corporation over and above the amount taken of.....	66,650

In the foregoing statement, the superficial area of McGill Street, within the limits of the station, has not been taken into account, as under any arrangement which could be made for furnishing the city with terminal accommodation at this point, a greater or less amount of the space occupied by this street would be required for the necessary sidings to facilitate the movement of trains and for their reception.

In the plan previously recommended for this portion of the work, it was proposed to place the buildings on nearly the same sites as now recommended, but with the rail and cart connections differently arranged. The freight station, bordering on Grey Nun Street, was to be 80 feet in width, but with no provision made for widening the street along which the traffic was to pass to and from the railway. Now supposing warehouses to be in existence on the west side of the street, as there certainly will be in time, with the long horse-trucks now in use, receiving or delivering goods and reaching to the middle of the road, with the same repeated on the opposite or station side of the street, it is manifest that the main thoroughfare would be completely blocked up, proving utterly insufficient for the purpose in view, and growing a more intolerable nuisance from year to year with the increase of the traffic, when too late to be remedied. The sidings, two in number, were to be placed on the east side of the freight station and occupy a portion of McGill Street, but unconnected with those belonging to the passenger depôt, on the east side, as will presently be seen. Now allowing that for a certain time the main line and one siding might afford the necessary facilities for the freight traffic, yet, with its increase, this amount of accommodation would be but insignificant, and no means at hand for its extension without appropriating a larger amount of the street, which in turn would infringe on the only route, of limited width, by which carriages could approach the passenger station on the east side.

There would in fact be a less amount of available siding at this grand terminal point than is possessed by any ordinary station along the line of the Grand Trunk Railway.

The passenger depôt was located, as before stated, on the east side of McGill Street and bordering directly on it. The building was to be 80 feet in width, with two lines of rails in rear, but under the roof or entirely within the building, and consequently not connected with the freight sidings after leaving the main line near the end of the swing bridge over the Lachine Canal. The carriage approach was to be along the portion of McGill Street intervening between the station and the freight sidings. Against the whole of this arrangement several important objections can be urged, some of which are as follows:

1st. The passenger sidings being confined within the building, no future addition to the number could be made without destroying the whole arrangement of the interior, and appropriating space required for other purposes.

2nd. In shunting and moving trains, the engines would require to go underneath the roof, filling the station with steam and smoke, while at the same time causing great danger to the building from sparks, cinders, &c.

3rd. In carrying out the entire plan on the east side of McGill Street as contemplated, a portion of it would be devoted to freight. In this case, no connection with the main freight depôt, on the west side, could be effected without crossing the swing bridge twice. This in itself would be a constant source of annoyance, expense, and delay, as the canal authorities, having the right of way, would to a great extent govern the movement of trains at their own pleasure.

4th. All the distance between the guard-lock and the revetment-wall would be occupied by an embankment, taking up much valuable space, and cutting off the canal from the harbor, for carriage and cart transit.

5th. No means of access to the rear of the building was provided for ordinary traffic. The portion of McGill Street intended for this duty, being incapable of future enlargement, would in a few years present the spectacle of carriages, carts, engines, and cars mixed up together in inextricable confusion.

It may perhaps be urged, that the plan referred to embraced a connection of the railway with the present harbor, and that by this means a large amount of through traffic each way would be taken directly to and from the vessels, and do away with the necessity of cartage. In answer to this it may be stated, there are so many difficulties in the way of effecting this union as to render it nearly an engineering impracticability, and even in a commercial point of view impolitic; but as the discussion of this part of the general question will be fully gone into in a more extended Report at a future period, it may suffice at this time to observe, that the height at which the rail over the canal must be placed so as to be beyond injury from ice, will be at least 18 feet above the level of the wharves, over which steep incline all traffic would require to pass. The most serious objection, however, is the sharp curvature from the end of the bridge to the line of the harbor, and unfortunately located on the same steep incline, as well as the large amount of valuable ground that would be occupied, or rendered useless for commercial purposes, by the embankment carrying the rail down to the lower level; the total want of room for siding accommodation when on that level; the interference with ordinary traffic between the harbor and city, and at the same time useless during the winter months from being covered with water. The proposed line along Commissioner Street in front of the city is open to many of the same objections. In fact, the more reflection bestowed on the subject, the stronger becomes the conviction that both nature and art have forbidden the iron bands of union between ship and rail traffic being consummated in this direction.

Reverting to the plan now proposed, it may be well to state briefly the peculiar advantages it possesses over the one previously recommended, even at the risk of recapitulating what has already been advanced:

1st. The line of approach from the guard-lock to McGill Street, leading over a viaduct instead of an embankment, occupies less of valuable space, will not interfere with the traffic passing underneath, and, raised three feet above the present line of McGill Street, places the rail above the highest flood.

2nd. Widening Grey Nun Street, and opening up a new one

in rear of the station on the east side of McGill Street, will give ample facilities for transport of freight to and from the respective stations for all time to come, be the increase what it may.

3rd. Converting McGill Street, up as far as William Street, into a station-yard, furnishes room for six distinct lines of siding, bounded on each side by an inward and outward freight-depot, with wide and accessible streets in rear of each for ordinary traffic. These sidings are of course external to the buildings, and all connected with each other at various points, so that trains may be moved from one to another without crossing the swing bridge, or even Common Street, the only level crossing between Point St. Charles and the city. By thus classifying the different freights, and confining each description of traffic to its own locality, greater expedition will result and confusion be avoided; the risk of destruction to the buildings by fire materially diminished; uniformity produced; and the fine view of the St. Lawrence and the Victoria Bridge from McGill Street not impaired.

These comparisons are instituted with no invidious object in view, but simply to show the importance of this entire portion of McGill Street being conceded for railway purposes in connection with the proper development of a City Terminus scheme susceptible of future extension to the extent indicated, as it is evident, in the plan now to be adopted ample provision should be made for any enlargement from time to time demanded by the rapidly increasing commerce of the city, harbour, and province generally, without in any manner marring the general features of the plan when eventually carried out to its full extent.

The total superficial area of station buildings when completed will amount to 154,620 square feet, or $3\frac{55}{100}$ acres.

On the south side of the Lachine Canal, between the swing bridge and the foot of the guard lock, it is proposed to reclaim a strip of ground from the river, of 600 feet in length by 250 feet in width. The two sides facing the river will be formed of wooden cribs, of sufficient width to furnish room for loading and unloading vessels, which a small amount of dredging will enable to come alongside. The space enclosed will be filled to the level of the external wharf, and on the completion of the Hydraulic Dock scheme will be carried up to the full height and form the sites for

a local engine-house, water-tank, turn-table, car and wood sheds, spare sidings, as well as houses for the use of the Company's employés in charge of the swing bridge, switches, and station yards. Those buildings being within the immediate neighbourhood of the terminus will enable engines to get wood, water, and stable-room without the necessity of proceeding to Point St. Charles, and be at all times convenient to the station.

The space lying between the main line and Windmill Point, on the south side of the canal, can be filled up to the surface of low water and laid off into mill-sites, with the head-race brought through the old locks of the canal, underneath a street, and from thence through mill-wheel sluices into the main tail-race of the Hydraulic and Dock Company.

The appropriation of this part of the embankment for milling and other purposes, will enhance its value materially, and with the revenue therefrom, will assist in paying for this portion of the work, otherwise chargeable upon the city terminus.

The water works tail race question which has also occupied considerable attention, and only second in importance to the terminal one, can be disposed of as follows: At the present time the water after leaving the wheels, is discharged into the river St. Pierre, and by a circuitous route carried into the St. Lawrence. The water in this river being shallow, freezes over in the winter to the bed of the stream, and causes an overflow on the surface of the ice; which being repeated frequently, in a short time converts the whole section of the river into a mass of solid ice, causing the water to set back upon the wheels, and impedes their motion. At the same time the anchor ice, carried from the river into the aqueduct at the upper end, dams back the water and lowers the head three feet more, as well as retarding the general flow of the water to such an extent as frequently to admit of but one wheel working, and that at a reduced speed; this, together with the six feet of head lost, impairs very materially the efficiency of the whole water works system, during the season of the year when most urgently required, in the event of conflagrations occurring in the city.

Now were it possible to lead the waste water into the mill basin of the Lachine Canal, the evil arising from the present tail race would be obviated, and the water now running to waste could be

brought into use at points where urgently required, but unfortunately the wheels are too low for this purpose by two feet. Several very expensive plans have been proposed by the Corporation, for constructing a tail race, to discharge below the Victoria Bridge, but either plan if carried out would get over only one of the difficulties, there still remaining the loss of head arising from the anchor ice in the aqueduct above, and which during severe weather requires constant blasting, in order to keep open a channel for supplying a sufficient amount of water for driving but one of the two wheels, to say nothing of the third wheel proposed. Neither would it be possible ever to withdraw the water from the aqueduct to execute repairs, now urgently required, by the filling up of the channel, from the side slopes having been made too steep, and sufficient width not having been given to its bottom.

Since the accompanying plans were prepared, the Corporation have decided on adopting a fourth route, not shown thereon, but may be described as a channel or open cutting, leaving the wheel house and following the line of the Grand Trunk Railway on the south side, in the direction of Wellington Street, which it crosses, and taking in a strip of land of considerable width, owned by the Nuns, west of the Grand Trunk property, terminates in a reservoir or excavated basin contiguous to the river margin, but leaving sufficient space between the two for mill sites and a tail race. Those mills are supposed to feed from the water in the new reservoir as supplied from the wheel house, with their waste water in turn carried, by means of the tail race just mentioned, through a tunnel underneath the embankment leading to the Victoria Bridge, and so into the river, by means of the tail race belonging to the Hydraulic and Dock Company. In the absence of more certain information respecting this scheme, it will not be proper to pass a decided opinion on its merits, but it is evident a large sum will be required to carry it into execution, from the height of land to be cut through south of Wellington Street. The most striking feature in it, however, is the application of the waste power for manufacturing purposes, and the cost by which such facilities would be obtained; for if it it be conceded that the water carried into the new reservoir or mill basin, as furnished by the two wheels, be sufficient to drive the machinery of several factories during the

summer months, yet as in the *winter* the supply will be restricted to an amount far less, being that furnished by but one of the wheels under partial headway, and the fall below the new mills at the same time much reduced by the backing up of the water from the river, it is almost certain that the factories so built would be inoperative during the winter season, and therefore failures. The object sought by the projectors, of making the lease of the supposed power pay the interest of the cost of construction, would not be realized, and without laying claim to much prophetic knowledge, it might with certainty be predicted that the plan would prove but a costly experiment, yielding no adequate results. A large portion of valuable ground, taken from the nuns, would also be lost for building purposes, as it is in this direction we must look for the homes of the artizans, mechanics, and labourers to be employed in connection with the new manufacturing establishments of the Hydraulic and Dock Company.

A much better route, in every respect, can be pointed out, should the following arrangement not be perfected.

To surmount all these difficulties, and at the same time to assist the general scheme, it is proposed to run an embankment up the river, as before mentioned, with the excavation arising from the construction of the new canal, to such distance as will gain two feet head over and above that now existing at the entrance into the aqueduct; which, being common to both canals, will enable the wheels to be raised one at a time to a like additional height, without interrupting the supply of water to the city, and thus bring the tail race on a level with the water in the reach below Lock No. 2 of the new canal, into which it would discharge itself, the water so gained becoming the property of the Company, and used in the main dock at the lower end.

A feeder can also be thrown from the upper reach of the new canal, immediately into the subsiding reservoir at the wheel house, to furnish water for driving the wheels during the time the smaller aqueduct would be undergoing repairs, and maintain that level to its full height for the winter months, instead of being drawn down three feet by anchor ice, as before stated; the water so lent, of course, reverting to the Company after performing this duty.

All the tail race difficulties would thus disappear, and the water

works be placed in such an efficient condition as no other plan could admit of; while, on the other hand, the Company, with the sum otherwise spent by the Corporation in making their proposed tail race, to surmount but one of their troubles, would perform a large amount of expensive work at the upper end of the new canal, gain two feet head, thereby saving two feet of difficult excavation in the bottom, obtain a large basin of still deep water, formed by the embankment terminating in a bell-mouth shape, in which vessels could remain if necessary, and easy of access to those coming down the river; while, during the winter, by freezing over, the anchor ice will be prevented blocking up the entrance into each canal, and damming back the water.

I have thus, Sir, endeavoured with the best of my ability to fulfil your stipulations, in the development of this extensive project; there are many points of detail on which I have not touched, in the course of this preliminary report, but have confined my remarks entirely to leading features, in order to give a clear conception of the whole scheme, and the mode in which it can be carried out with economy, stability, and usefulness in every department.

In conclusion, I have to express my thanks to the following gentlemen, for the kind manner in which various plans showing the adjacent country were placed at my disposal, saving at this time a large expenditure for the necessary surveys:—The Harbor Commissioners; Walter Shanly, Esq., General Manager, Grand Trunk Railway; J. G. Sippell, Esq., Government Engineer; Messrs. Cliff and Lesage, Corporation Engineers; and David Aikman, Esq.

I have also received valuable assistance, in the preparation of the various drawings, from my two assistants, Mr. John Y. Lloyd and Mr. Arthur D. Ross.

The accompanying pages will show, in a condensed form, the amount of motive power, number of mills, length of dockage, &c., &c.

I have the honor to be, Sir,

Your obedient servant,

CHARLES LEGGE,

Civil Engineer.

STATEMENT OF DISTANCES, HYDRAULIC POWER, NUMBER OF LOTS, &c., &c.,

IN CONNECTION WITH THE

HYDRAULIC AND DOCK SCHEME.

Distances.

From Wellington Street to Lock No. 2 .... 7,200 ft. = 1·36 miles.
From Lock No. 2 to junction with River,... 23,400 ft. = 4·43 "

Total, 30,600 ft. = 5·79 "

Hydraulic Power.

Lowest level of water at m[illegible] of Water Works aqueduct above level of water in Montreal Harbor, as recorded by the Superintendent of City Water Works, ...36·909 feet.
Highest level of water do. do. .....41·000 "

2)77·909 "

Average, 38·95 "
Add amount to be gained by Embankment,..... 2·00 "

Average above Harbor,....40·95 "

Fall at Lock No. 1.

Main dock,.....26·00
Hydraulic inclination from Lock 2 of 3″ per mile for 1·36 miles, ... 0·34
Do. from Lock No. 2 to upper end of Canal, 3″ per mile for 4·43 miles,..... 1·11

27.45 "

Fall at Lock No. 2 = ...13·50 "

Canal assumed at 160 feet on bottom, 14 feet deep, slopes 2 to 1, hydraulic inclination 3″ per mile, will give a velocity of 1·27 miles per hour, and furnishes a power at the different Locks as follows :—

Lock No. 1, Head 22½ feet, ...12,584 Horse power.
" No. 2, " 13½ " ..... 7,550 " "

Total, 20,134 " "

The same dimensions retained, but with an hydraulic inclination of 6

inches per mile, will give a velocity of 1·91 miles per hour, and furnishes a power at the same points as follows :—

Lock No. 1, Head 21·82 feet, ...18,273 Horse power.
" No. 2, " 12·02 " ....10,066 " "
Total, 28,339 " "

By increasing the width of canal to 300 feet on bottom, 14 feet deep, slopes 2 to 1, hydraulic inclination of 3″ per mile, will give a velocity of 1·32 miles per hour, and furnishes the following power :—

Lock No. 1, Head 22½ feet, ...22,086 Horse power.
" No. 2, " 13½ " .....13,455 " "
Total, 35,541 " "

The same dimensions retained, but with an hydraulic inclination of 6 inches per mile, will give a velocity of 1·95 miles per hour, and furnishes power at the different Locks as follows :—

Lock No. 1, Head 21·82 feet, ...32,618 Horse power.
" No. 2, " 12·02 " ....18,002 " "
Total, 50,620 " "

GENERAL ABSTRACT.

Lock No. 1.

Lift 26 feet. Hydraulic mean height above summer level 22½ feet.
18,273 horses, minimum power proposed.
32,618 " maximum " "
44 Flouring Mill sites, of 150 feet square and upwards.
84 Sites, of 100 feet square and upwards, for miscellaneous manufactories.
93 Warehouse Lots, of 150 feet square and upwards.
1 large Dry Dock, 550 feet long by 100 feet wide, for ocean steamers, &c., or capable of being converted into two smaller ones of 275 feet long by 100 feet wide each, for ordinary vessels.
152 acres of surface in large reservoir or main dock.
27½ acres " in distributing reservoir or inner dock.
9,630 lineal feet of dockage in large dock, } = 22,960 ft. or $5\frac{1}{10}$ miles.
17,330 " " " inner docks, }
19 miles of railway siding when all carried out.

On modified plan of inner docks, which confines them to the land owned by the Provincial Government :—

8,380 lineal feet of dockage in large dock, } = 19,340 ft. or $3\frac{7}{10}$ miles.
10,960 " " " inner docks, }
14½ miles of railway siding when completed.

Lock No. 2.

Lift 13½ feet to 12·02 feet.

10,066 horses, minimum power proposed.
18,000 " maximum " "

93 Lots for manufacturing purposes, of 150 feet square each and upwards.

7½ miles of siding when completed.

$5\frac{79}{100}$ miles, total length of canal.
40·95 feet, total fall of canal.
1·45 " total minimum fall lost by hydraulic inclination.
2·89 " " maximum " " "
1·95 miles per hour maximum current through canal.
28,339 horses minimum power of water.
50,618 " maximum " "
221 total number of lots for milling and manufacturing purposes.
93 warehouse lots, or
37 " " on modified plan.
128½ horses average minimum power for each manufacturing establishment.
229 horses average maximum do. do. do. do.

CHARLES LEGGE,
Civil Engineer.